THE VETERINARY JOURNAL

EDITORS: T. DALLING, *M.A., M.R.C.V.S.* J. McCUNN, *M.R.C.V.S., L.R.C.P.*

Vol. 102 December, 1946 No. 12

EDITORIAL

ANIMAL BEHAVIOUR

THE animal body is probably the most intricate of all the wonderful works of Nature.

No machine that man has devised can compare with its superb and balanced structure, its mechanical efficiency, or with the delicacy and finesse of its control. This control may be under the will of the animal or it may be automatical. Throughout the ages a great wealth of information dealing with structure and function has been disclosed. Discoveries in this realm of knowledge have revealed further fields for research, and especially is this so in the matter of control. We know that the nervous system, voluntary and involuntary, exercises a great influence in the control of the animal mechanism. We know that much of its action can be translated into terms of reflex action, but in many cases we do not know the nature, or even the site, of origin of the initial stimulus to action. Man and animal react to environment; indeed, environment plays a tremendous influence on the body not only in the physical sense, but also in terms of character, temperament and behaviour. In man these latter factors have a tremendous influence on his mode of life and on his relations with his fellows. They determine whether he be idle or energetic, whether he be cheerful or morose. They influence his choice of career and the success or failure which attends thereon. In animals one may notice similar reactions. Who has not been thrilled by the gay, energetic, thoroughbred hackney enjoying every minute of the show and applause, and, in contrast, been dulled by the coarse-bred, lazy beast in the carrier's cart. In man the genesis of these reactions, which may be classed broadly under the title of behaviour, has been attributed to that imaginative and indefinite thing called the mind, or soul. In animals, which are supposed to be lacking in such an attribute, explanation has been made that it is the result of intuition or instinct. In both cases this illative explanation is illusory when judged by modern standards.

XUM

In man the brain, especially the cortical areas, is well developed, and his behaviour is in many ways correlated to this development. In animals this high state of development is not observed, but the senses are extremely acute, and there are some who would interpret animal behaviour in the terms of sense reflex.

The cortical theory is not an absolute one even in man, for it is known that large areas may be removed or destroyed with often no apparent effect upon behaviour.

In recent years much attention has been given to the analysis of the mind of man with the primary object in view of explaining and correcting aberrations of conduct or behaviour.

This study has been given great impetus during the war years, for the stress and strain of war is a great disturber of normal conduct and function. Great strides have been made, but, just as in other branches of medical science, the human specialist finds that he must turn to animals for the solution of many of his problems.

It is good, therefore, that veterinary surgeons should in turn play their part in this field, and that our students should enter with the true zest of the pioneer.

Much knowledge is already available, but it is not to be found on the library shelf; it is stored in the minds of observant stock-keepers and in our country lore.

Some of this information is the product of original observation; much has been passed on from generation to generation.

A first step should be to collect and collate these observations, subject them to critical analysis, and then, if substantiated, make them available to all.

The veterinary surgeon who will interest himself will soon become an enthusiast; he will find it easier to speak and understand the language of the stock-keeper, and he will help to build up a fount of knowledge which will be of the greatest value to himself in his vocational activities, and advance a science, as yet in its infancy, which will be of incalculable benefit to mankind.

GENERAL ARTICLES

LEUKÆMIA IN DOGS

Including a Record of a Case Treated by Urethane

By J. R. M. INNES, H. B. PARRY and J. BERGER*

Biological Laboratories, Imperial Chemical Industries, Manchester.

Introduction

HADDOW and Sexton (1946) and Paterson and Haddow *et al.* (1946) have published data on the influence of urethane (ethyl carbonate) on experimental animal tumours and on human leukæmia. Although the mode of action of the drug is unknown, these observations are of significance regarding the chemotherapy of cancer as a whole, and leukæmia in particular. In the most favourable human cases of leukæmia there was a fall in the total white cell count, the differential count tended to approach the normal pattern, the size of spleen and palpable lymph nodes was greatly reduced and the hæmoglobin level rose, which were effects similar to those obtained in the standard treatment by deep X-ray. The pursuit of similar trials using spontaneous tumours of dogs has been a tentative project in these laboratories for some time. Leukæmia in dogs is of relative rarity and to accumulate data from a sufficient number of cases would take considerable time. It is desirable to record the results obtained in one case of leukæmia in a dog because of the dramatic remission which occurred following the administration of urethane. This may stimulate clinical research by others in the same direction so that some clearer concepts regarding this peculiar action by urethane may be quickly obtained.

Leukæmia in Dogs

The lack of accurate clinical and pathological data regarding tumours in the lower animals is nowhere more marked than in the case of the groups which arise from the hæmopoietic and the reticulo-endothelial system. Some consideration is given to existing knowledge concerning this disease in dogs compared with man. This has a bearing on the case which was treated with urethane and may be of use to those who may conduct other clinical trials on canine leukæmia.

The term *leukæmia,* originally given by Virchow, literally designates only a phase of disease in which cellular changes occur in the blood subsequent to primary initiation of a process in the blood-forming tissues. A somewhat confused nomenclature was gradually evolved as different forms have become known, but at present it might be defined as a uniformly fatal disease of man and animals characterised by a systemic hyperplasia of the leucopoietic cells of the blood-forming tissues and consequent lymphoglandular enlargement; at some stage there may be an increase of certain types of mature and immature white cells in the blood stream. This systemic involvement of lymphoid and myeloid tissues is thus a characteristic differentiation between "leukæmia" and certain lymphoid and myeloid tumours, e.g., lymphoma, lymphosarcoma, lymphoepithelioma, chloroma and myeloma, in which there is an essential primary

* Practitioner, Alderley Edge, Cheshire.

regional site and in which spread occurs by contiguity, local invasion and metastases like any other form of malignant cancer. Classification of the systemic types of disease in man (and the animal pathologist must follow suit at present) is largely provisional because there is no knowledge of ætiology and because there is much difference and variation of opinion in hæmatology regarding the histogenesis of the blood cells and their precursors from which all the neoplastic diseases arise. In recent years a considerable medical literature has grown dealing with certain other conditions which were at one time confused with leukæmia (many cloaked under the name of pseudo-leukæmia), viz., reticuloses, which also arise in the reticulo-endothelial system and of which there are several distinct types. They also may produce lymphoglandular and splenic enlargement, but of the several different types known none have been clearly recognised in animals. This might be stressed in relation to the entity called Hodgkin's disease (lymphadenoma), now regarded as a class of reticulosis. In this country reference is still made to Hodgkin's disease in dogs, although no case has been described which shows all the peculiar clinical and pathological manifestations of this disease in man.† Briefly, these include a primary site involvement of a lymph node, followed by spread elsewhere, splenomegaly, a progressive anæmia usually with a well-marked eosinophilia, mild spells of fever of relatively short duration, and an invariably fatal termination. The histological picture has for long been regarded as diagnostic, seen in the combination of (a) large pale cells of an epithelioid type so that it may closely resemble certain forms of tuberculosis; (b) bi- and multi-nucleated giant cells known as Dorothy Reed or Sternberg cells; (c) eosinophils; and (d) in the later stages, of fibrosis. If we exclude the neoplastic or neoplastic-like conditions of the hæmopoietic tissue which are regional and that group known as reticuloses and reticulo-sarcomata arising from the reticulo-endothelial system, we are left with a type commonly classed under the general term leukæmia and which occurs in man and many of the lower animals. (Although the term leukæmia strictly refers to changes in the blood, the word has achieved special significance in terms relating to a specific disease. To avoid confusion there is something to be said for terminology used mainly in German literature, viz., myelosis and lymphadenosis, in each of which there may be aleukæmic or leukæmic types, or phases.)

In man (see Boyd, 1943; Vaughan, 1938; Piney, 1939; Robb-Smith, 1938; Forkner, 1938) there are three main types: (1) Myelogenous (myeloid, myeloblastic leukæmia or myelosis), arising from the stem cells of the marrow and splenic pulp, etc. (2) Lymphogenous (lymphatic or lymphoblastic leukæmia, leukosis lymphadenosis or lymphomatosis), arising from reticulum cells of lymphoid follicles. (3) Monocytic leukæmia dependent on a hyperplasia of the histiocytes derived from sinus reticulum, but which more properly would be included under the reticuloses. In each of these varieties acute and chronic clinical forms are recognised, depending on whether they prove fatal within six

† No undisputed cases of Hodgkin's disease have been recorded in any animal; the few case reports in English veterinary publications are all based on clinical resemblances and to the presence of generalised lymphadenopathy. There has almost certainly been some confusion with leukæmia. One case in a dog by McMahon (1934) in U.S.A. is suggestive histologically. The record of an occurrence of a peculiar lymphogranuloma-like disease in pigs by Forbus and Davies (1945) is of more interest, but further work requires to be done.

months or longer, and in each there may be leukæmic and aleukæmic phases, the former perhaps being simply a late development of the latter. Typical cases of lymphadenosis or myelosis without blood changes persisting thus to the end are, however, well recognised in man and have been also seen personally in dogs and a horse.

In the dog and, in fact, in most domestic animals, the occurrence of a myeloid form is highly debatable. The few records of what is deemed to be myeloid leukæmia are inadequate and much more evidence will be required before accepted facts concerning human myeloid forms can be compared to any similar animal condition. We only deal, thus, with lymphatic leukæmia. Good general descriptions are to be found in the publication by Wirth (1931), the review on animal leukosis in general by Jarmái (1934), Hutrya and Marek (1938), and Joest (1929). Experimental work on leukæmia in animals is summarised by Furth (1946). In the excellent review on leukæmia in animals by Engelbreth-Holm (1942) the canine aspect is dealt with only in very general terms. More recently, White (1946) summarised his experience from pathological studies of 44 cases. Bloom and Meyer (1945) deal with the subject in great morphological detail, based on an examination of 20 cases. They suggest that the term "leukæmia" be replaced by malignant lymphoma because of an absence of blood changes, but leukæmic and aleukæmic cases of lymphadenosis in dogs are seen just as in the case of man. They apparently encountered only the type which we refer to elsewhere as "*leukæmia with a leucocytotic blood picture.*"

The following observations are partly based upon information given in the above publications, also on a personal study of over 30 cases in dogs (some of which were examined jointly, some only clinically by H.B.P. and J.B.; 17 were autopsied), together with a great volume of other material relating to tumours of lymph nodes, spleen, etc., from all animals and man for comparison.

Without going into details, it can be stated that there is no conclusive evidence that the disease is caused by any infective agent, which places it in a different category from avian leukæmia. Further, there is good evidence to support a very old view that leukæmia in general is a neoplastic process. It is difficult to assess at all the frequency with which it occurs. Any animal studies which have been carried out, whether clinical or pathological, have been made on material usually from a highly selected source of the dog population. There is still need for accurate recorded data of a large series of cases with sufficient clinical, hæmatological and pathological information to enable a critical view to be taken of the disease as a whole.

Clinical Aspects

There appears to be little ground for subdividing leukæmia in dogs into acute and chronic forms; all seem to have an insidious onset, but an extremely rapid development once the disease begins; all terminate fatally in a few months. Insufficient data is available to determine whether the disease is more prone to occur in the male than in the female, as is the case in man; in our own series the cases occurred in about equal proportion, and with one exception they have all been relatively adult dogs. A similar finding is reported by White (1946). All breeds are prone to the disease, but White (1946) and Bloom and

XUM

Meyer (1945) both mention a high incidence in Aberdeen terriers (three of our cases were in that breed).

One form of canine lymphadenosis (leukæmia) corresponds closely to that observed in other animals and man; there is another which has the same typical gross pathology but shows changes in the blood picture which resemble a non-specific polymorph leucocytosis (German workers refer to this as *"leukæmia with a leucocytotic blood picture"*). "Leukæmic and aleukæmic" cases certainly occur in the dog, but the former may be simply a late developmental phase of the latter, occurring with more acuity of onset or as a terminal event in the last few weeks of life.

The early stages of the disease are usually unaccompanied by any indications of ill-health; the first signs to be observed are symmetrical enlargement of the superficial lymph nodes all over the body, and precedes any general systemic signs by periods not clearly known but perhaps varying from a few weeks to a few months. This stage might be termed the lymphatic phase in which the body and the disease process are essentially in equilibrium. There are no clear records of spontaneous remission of the disease.

The lymphatic phase proceeds to a systemic one in which there are signs indicating involvement of the main body systems. There is progressive anorexia, with, in some cases, diarrhœa (see also White, 1946), and loss of condition, which may advance to frank emaciation in a few days. (Compare Figs. 1 and 2.) There are respiratory signs of polypnœa and dyspnœa, and the cardiovascular system exhibits tachycardia. Enlargement of all palpable lymph nodes may become gross and subcutaneous œdema, especially of the throat, face and axillary region, may appear within a few days of death. Changes in the eye, either the accumulation of white cells in the anterior chamber or actual hæmorrhage into the chambers of the eye, with temporary interference with vision have been seen, but records of detailed ophthalmic examination of such cases are not available. The terminal phase is characterised by very rapid wasting of skeletal muscles for two-to-three days before death, when anorexia is complete. The cause of this muscle wasting is not understood and is much more marked than that in simple starvation, but whether it is due to an increased basal metabolic rate is unknown.

During this systemic phase the animal is very liable to develop mild chronic inflammation of the upper respiratory tract with nasal catarrh and even pneumonia, but the exact pathogenesis of death in uncomplicated cases has not been determined, as most canine cases are killed before or at this stage. The termination is not, however, due to the changes in the cellular elements of the blood alone.

Neurological signs, data on changes in the C.S.F. or urine analyses have not been reported. Evidence of the nature and extent of bone involvement, which is common in man, is also not available in canine leukæmia.

Hæmatology

Although the changes in the tissue are paramount, alterations in the blood are of importance in diagnosis and in any consideration of pathogenesis. In the early stages no apparent changes may be seen, but later in one form of the disease (true leukæmia) there may be a very high total white count; figures of 280,000 per cmm. have been seen. Differential counts reveal that this is due to an enormous increase in the circulating lymphocytes—small and large varieties are

found and the latter may predominate (Fig. 3). A fulminating case has been seen in which the blood was severely involved at an early stage of generalised lymphadenopathy and advanced disease has been seen with aleukæmia, i.e., with no alteration in the total white cell count. Mention has been made of the other type of disease referred to originally in German work as *"leukæmia with a leucocytotic blood picture"* (see Engelbreth-Holm, 1942). Two cases have been recently observed by ourselves; one was the subject upon which urethane was tried and full details are given later. The same gross pathology is encountered in both types involving lymph nodes, spleen, liver, etc., but the blood picture shows a moderate increase in the total white count due to a polymorphonuclear leucocytosis, and some of the reported cases of myeloid leukæmia may have been of this nature (Fig. 4). The explanation of this feature is difficult and it may be non-specific. Engelbreth-Holm (1946) states that the leukæmic process in these cases may not involve the bone marrow and that the latter can react with a leucocytosis which fails to occur in cases where the marrow tissue is replaced by lymphoblastic tumour tissue. With increase in severity of the disease, a secondary anæmia develops and the red cells and hæmoglobin may be markedly reduced. Hæmorrhage from the nose, into the retina and even grossly into the chambers of the eye have been observed personally. In human cases such hæmorrhage has been suggested to be caused by a concurrent thrombopenia (Engelbreth-Holm, 1946); no observations have as yet been recorded in animals.

Pathology

Anatomical:

In both types (lymphadenosis with leukæmia or with a leucocytotic picture) a similar pathology is found. If the dog is allowed to survive until late cachexia is present to an extreme degree. Universal enlargement of superficial and visceral *lymph nodes* occurs and may reach enormous proportions; there appears to be no proneness for any group of nodes to be involved more than others. They may be firm and fleshy and foci of hæmorrhages and necrosis are common. In the early stages the glands may be freely movable from surrounding tissue, while later they may be involved in areas of localised œdema, particularly in dependent regions such as under the jaw and neck. An outstanding feature in late cases, at least, is *splenomegaly* (weights of 500-700 g. compared with 30-50 g., normal dog, have been seen). One case has been autopsied in which the spleen was not involved at all, which suggests that the primary initiation of the process is in lymph nodes. With gross enlargement of the spleen the organ may be turgid with a tense capsule, which, when cut, causes herniation of soft pulpy splenic tissue. The organ may be deep red in colour in which no trace of the paler Malpighian corpuscles can be seen. Subcapsular hæmorrhage is common and gross, small and large pale necrotic infarcts have been seen. The *liver* is generally enlarged (weight of about 1,500 g. compared with about 300-500 g., normal dog). The organ in such cases extends well beyond the costal margin, is firm, tense and taut and with the margins rounded. *Transudates* in the peritoneal, pleural and pericardial cavities occur probably due to the effect of enlarged mesenteric and mediastinal glands. No involvement of thymus has been seen in dogs. The *kidneys* may show disseminated minute pale foci or

XUM

both may be enormously enlarged with a tense capsule, with an extremely pale, blurred pattern due to widespread diffuse leukæmic infiltration involving mainly the boundary zone. The *marrow* is nearly always involved—the normal yellow fatty marrow of the long bones of adult dogs is replaced by greyish red tissue. Few animals are allowed to die naturally so the sequence of superimposed terminal events is not well known.

Histological:

The normal architecture of *lymph nodes* (Figs. 8 and 9)—sinuses, germ centres, follicles, pulp cords, etc.—becomes largely obliterated by a uniform hyperplasia of cells of the lymphoblastic type—large, round cells with vesicular nuclei closely packed into a mosaic form quite distinct from small lymphocytes which are, in fact, inconspicuous. Mitoses are extremely numerous. The peripheral sinus and medullary sinuses may be packed with these cells and at a later stage the capsule is invaded and there may be extensive infiltration of all the loose pericapsular tissue. Hæmorrhage and necrosis is a common sequel. In the *spleen,* essentially the same picture is found, viz., obliteration of the normal structure of Malpighian corpuscles, red pulp, sinusoidal systems, by the disorderly overgrowth of lymphoblasts (Fig. 13.) In cases with advanced leukæmic involvement of the blood the normal fatty *marrow* seen in the long bones of adult dogs is replaced by a massive tumour tissue composed of cells identical in type with those seen in the lymph nodes (Fig. 7). Erythropoietic tissue and megakaryocytes are scanty or lacking. In those cases with no blood changes, or with a leucocytotic blood picture, the lesion is different and obviously might vary according to the stage in which the disease is seen. In two cases examined (Figs. 5 and 6), myeloid activity was undoubtedly marked, but towards the production of granular leucocytes, which is quite in accordance with the leucocytosis seen during life. These are features which require further study. Infiltration in the *liver* (Fig. 11) takes the form of focal and nodular disseminations of lymphoblasts, surrounding the portal tracts or involving the parenchyma proper, the liver cells being squeezed aside to undergo pressure atrophy. If there are blood changes, the sinusoidal system may be packed with tumour cells. Similar cellular infiltrations, or hyperplasias, seem to be very common in the *lungs* (Fig. 10), forming focal, perivascular and peribronchial nodules of a moderate to severe degree to such an extent that the naked eye section of lung is reminiscent of acute miliary tuberculosis; peculiar diffuse subpleural infiltration has also been seen together with patches of fibrinous pleurisy. No doubt this picture might be complicated further by œdema, hæmorrhage, infarction or pneumonia if canine cases were allowed to die naturally. Lymphoblastic infiltrations may be found in other organs, viz., amongst those noted by ourselves were *thyroid, pancreas, suprarenal, tonsil, heart,* and, perhaps more commonly, the *kidneys.* In the latter we have seen lesions either as minute discrete cortical foci of lymphoblasts (not to be confused with the occasional disseminated foci of lymphocytes seen in many normal dogs' kidneys) or as a diffuse interstitial infiltration affecting mainly the boundary zone (Fig. 12).

Comment

It would seem that canine lymphadenosis (leukæmia) corresponds closely in its nature, course and fatal termination to the disease seen in man, although there

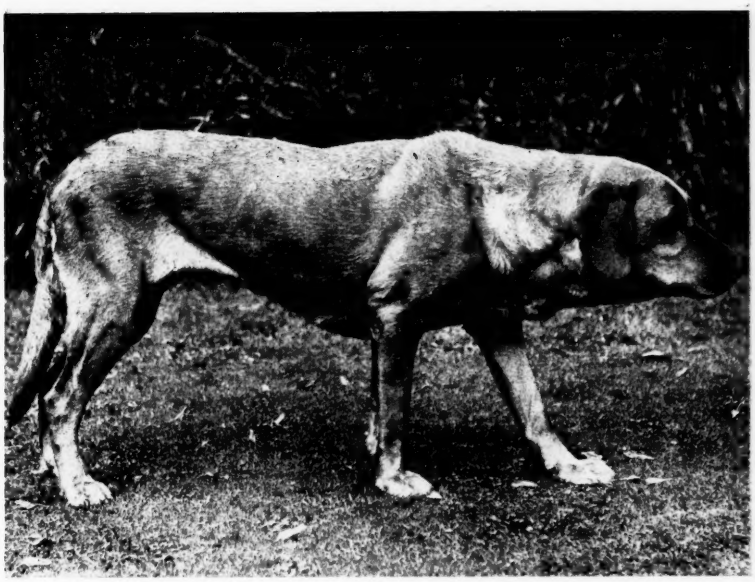


FIG. 1.—*Acute lymphatic leukæmia* (Acute lymphadenosis with leucocytotic blood picture). Golden retriever 4½ yrs. F. Photograph taken 9.8.46. Six days after treatment began: 2 gm. Urethane/daily. When treatment was begun, 3.8.46, the animal was in a similar condition to that shown in Fig. 2—two days before death.

FIG. 2.—*Acute lymphatic leukæmia.* Same case as Fig. 1, two days before death. Relapse begun on 23.9.46 with rapid development of cachexia. The massively enlarged prescapular lymph nodes and localised œdema under jaw are clearly seen.

XUM

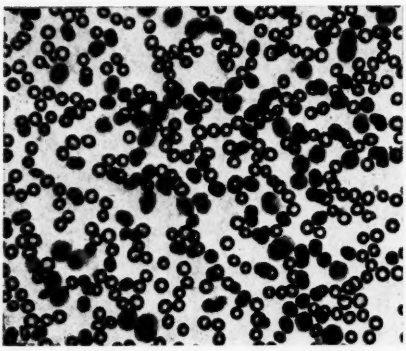


FIG. 3.—*Acute lymphatic leukæmia* (Acute lymphadenosis with leukæmic blood picture). Terrier, 18 months, M. Rapid onset of symptoms and loss of condition. Killed. Blood examination day of death: Rbc's, 3,650,000/cmm.; Wbc's, 282,000 cmm.; Hb, 53%; differential count, small lymphocytes 56%, large lymphocytes 22%, monocytes 19%, neutrophils 3%. *Autopsy*: Generalised moderate lymphoadenopathy, splenomegaly, leukæmic infiltrations, liver, kidney, etc. *Blood smear* showing numerous lymphocytes mainly large, and lymphoblasts in one field.—May-Grünwald Giemsa, x 250 (285.46).

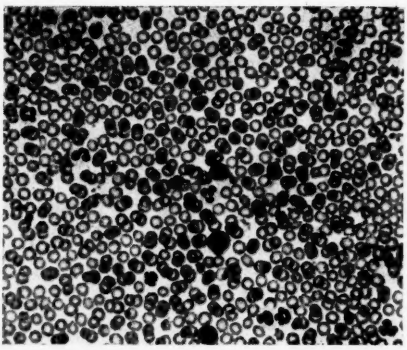


FIG. 4.—*Acute lymphatic leukæmia* (Acute lymphadenosis with leucocytotic blood picture). Same case as Figs. 1 and 2. *Blood smear* taken before treatment with urethane. Wbc count, 40,000/cmm.; a number of mature polymorphonuclear leucocytes in one field.—May-Grünwald Giemsa, x 250 (256.46).

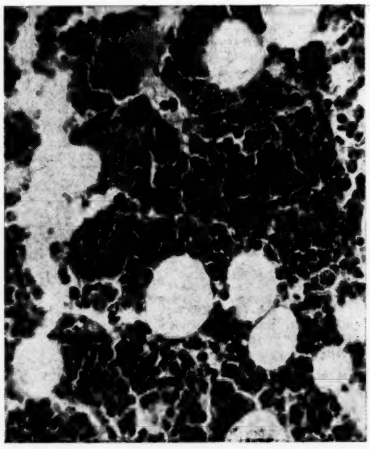


FIG. 5.—*Acute lymphatic leukæmia.* Same case as Figs. 1, 2 and 4. *Marrow*: Little fatty or erythropœitic tissue present; numerous myeloblasts and immature polymorphonuclears; lymphoblasts not numerous; occasional megakaryocyte.—H.E., x 250 (256.46).

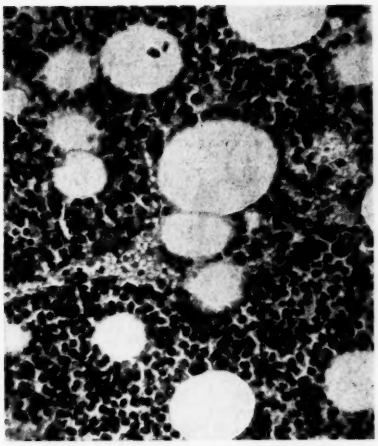


FIG. 6.—*Acute lymphatic leukæmia* (Acute lymphadenosis with leucocytotic blood picture). Scottie, 9 yrs., F. Blood counts: Rbc's, 5,250,000; Wbc's, 52,000; neutrophils, 86%. *Autopsy*: Generalised moderate enlargement of lymph nodes (with typical histology); no involvement of spleen or liver. *Marrow*: Showing appearance in this type or phase of disease—a highly active myeloid tissue—myeloblasts, myelocytes, and mature and immature neutrophils.—H.E., x 250 (277.46).

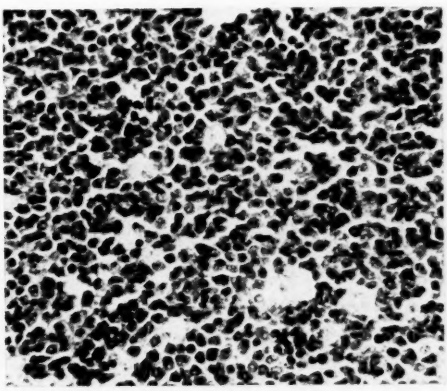


FIG. 7.—*Acute lymphatic leukæmia* (Lymphadenosis with leukæmic blood picture). Same case as Fig. 3. *Marrow*: Showing typical lymphoblastic proliferation, little myeloid, fatty, or erythropoietic tissue.—H.E., x 250 (285.46).

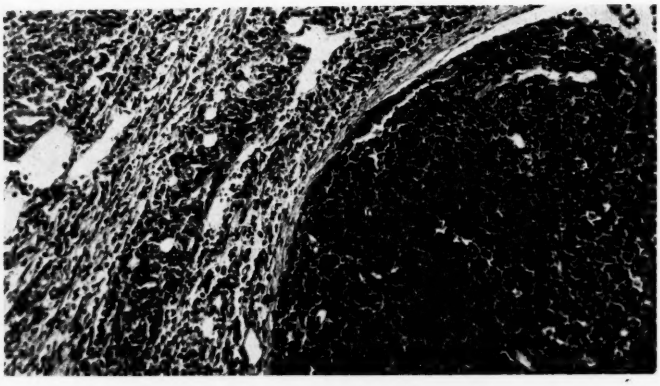


FIG. 8.—*Acute lymphatic leukæmia,* same case as Figs. 1, 2 and 4. *Lymph node*: Obliteration of normal structure by uniform hyperplasia of lymphoblasts, invasion of tissue beyond capsule.—H.E., x 116 (256.46).

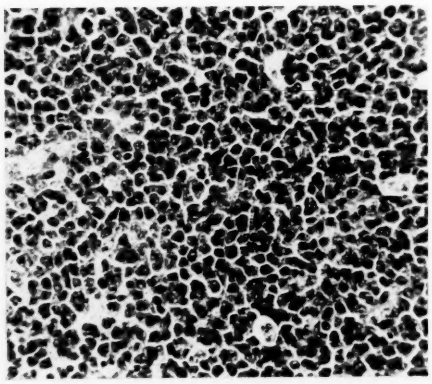


FIG. 9.—*Lymph node.* Same section as Fig. 8—field under higher magnification. Lymphoblastic type of cell closely packed, few small lymphocytes, numerous mitoses.—H.E., x 250 (256.46).

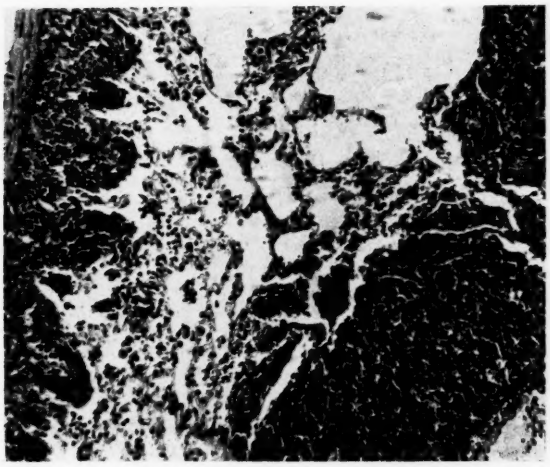


FIG. 10.—*Acute lymphatic leukæmia* (Lymphadenosis with leukæmic blood picture). Airedale, 6 yrs., F. Blood examination day of death. Rbc's, 3,720,000; Wbc's, 232,000. Similar autopsy findings to case in Figs. 1, 2 and 3. *Lung*: Nodular disseminations; *Pleura*, left with marked subpleural mantle of lymphoblasts; massive peribronchial and perivascular lymphoblastic infiltration—few alveolar phagocytes present.—H.E., x 116 (1744.8).

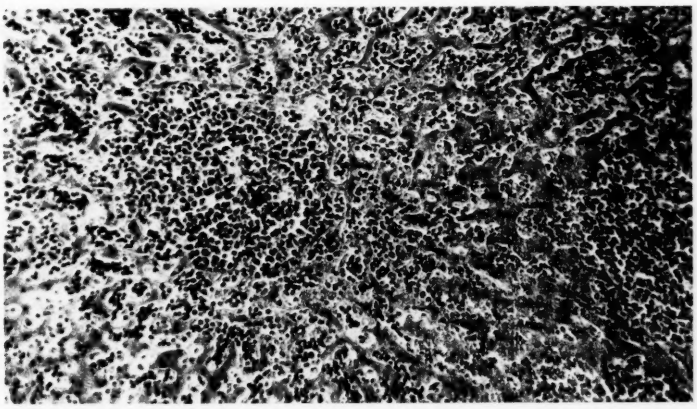


FIG. 11.—*Acute lymphatic leukæmia*. Same case as Figs. 3 and 7. *Liver*: Gross disseminated nodular leukæmic infiltrations, aggregations around portal tracts, small foci in parenchyma, and marked infiltration in sinusoidal system.—H.E., x 116 (285.46).

XUM

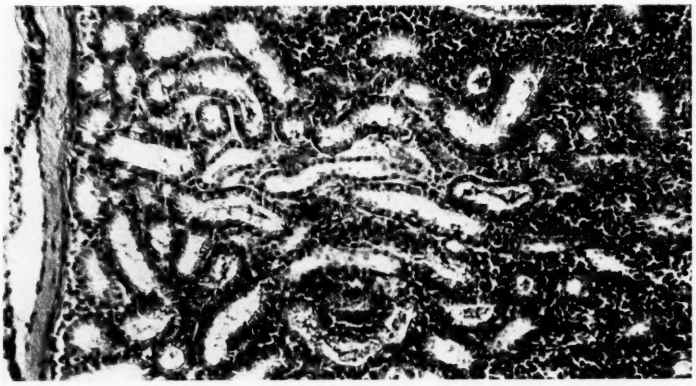


FIG. 12.—*Acute lymphatic leukæmia.* Same case as Figs. 3 and 7. *Kidney*: Showing massive diffuse leukæmic infiltration of interstitial tissue, more pronounced in boundary zone.—H.E., x 116 (285.46).

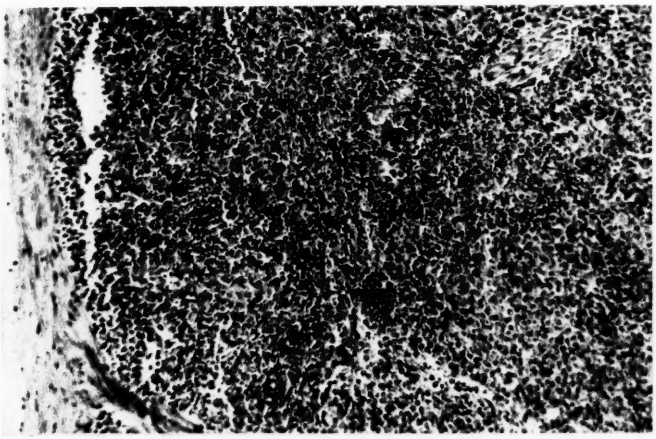


FIG. 13.—*Acute lymphatic leukæmia.* Same case as Figs. 1, 2, 4, etc. *Spleen*: Capsule and part of trabecula on left; no malpighian corpuscle present; obliteration of normal white and red pulp tissue by hyperplasia of lymphoblasts.—H.E., x 116 (256.46).

is still need for further accurate observations to be made. For example, no data are available regarding possible involvement of the nervous system, of the skeleton, nor of the skin, all frequent enough complications in human leukæmia. The occurrence of a true myeloid type is debatable and there would appear to be no point in a clinical subdivision of acute and chronic forms. As in man with the involvement of lymph nodes, spleen, liver and bone marrow, there may be a phase in which a pronounced leukæmia (using the word in its true sense) does occur and which will persist until death unless treatment is given, i.e., the blood picture to some extent is a mirror of the course of the disease within. There is no clear-cut explanation just how, or when, the blood is involved. The disease in the dog is complicated by the occurrence of a peculiar form with the same gross visceral pathology but in which cellular changes in the blood are those of a non-specific polymorphonuclear leucocytosis. The pathogenesis of this type still awaits clarification, and in some publications this has been the only type encountered. The infiltrations seen in other organs besides lymph nodes, spleen and marrow, viz., liver, lung, kidneys, etc., probably represent localised hyperplasias of undifferentiated leucopoietic foci rather than metastatic development.

The eventual course of the canine disease as a whole seems to be the same inevitable one of death, most dogs being destroyed in the terminal stages. No record exists of any spontaneous remission and there is a similar lack of decisive records indicating that any form of medicinal treatment has any permanent value at all. The effect of deep X-ray has not been extensively studied, but there is no reason to disbelieve that it would have the same beneficial effect as in man of prolonging life. Arsenic and benzol have also been recommended as a palliative measure, although no detailed records are again available; both might have some effect, the former in virtue of its effect on the mitotic cycle and the latter simply as a marrow poison.

Record of Lymphadenosis (Lymphatic Leukæmia) (Dog) Treated with Urethane

1. *Subject*: Dog, Golden Retriever bitch, 4½ years.

2. *History*: The animal was a suburban household pet and well cared for. Ill-health noted a week previously, loss of appetite and of condition with moderate swelling of the throat, and frequent bouts of panting.

3. *Clinical findings*: 19.7.46. Good general condition, well fleshed, alert and energetic. Temperature 100.7° F. Respiration polypnœic, shallow without thoracic abnormalities on auscultation. Heart and pulse frequencies high (130), regular and rhythmic, with peripheral pulse (femoral) of small amplitude, narrow pulse pressure and soft tone. General, 6-8 fold bilateral symmetrical enlargement of the superficial lymph nodes (parotid, mandibular, prescapular, axillary, popliteal and supramammary), which are firm, painless and freely movable on palpation. Liver and spleen and abdominal lymph nodes no palpable enlargement. Subcutaneous œdema of the intermandibular space. Teeth, mouth, tonsils, eyes and nasal cavities no abnormality. *Hæmatology*: Hæmoglobin (Sahli), 125%. Erythrocytes: 8,460,000 per cu. mm. Leucocytes: 14,200 per cu. mm. Differential count: 69% neutrophil polymorph, 14% lymphocytes, 8% monocytes and 7% immature myelocytic forms. Neutrophils—completely segmented nuclei 32%, 7% band nuclei, and 30% partially segmented nuclei. *Biopsy*: 23.7.46; *Left popliteal lymph node—Histology*: Complete loss of normal structure of follicles, sinuses and trabeculæ due to uniform infiltrations and hyperplasia of large and small round cells of the lymphoblastic type; numerous mitoses; slight invasion of the capsule; no hæmorrhages or necrosis. By the 2.8.46 there was considerable loss of condition, shedding of coat hair and the dog was less energetic; œdema of intermandibular space increased. Lymph nodes slightly larger. Marked leucocytosis.

XUM

4. *Diagnosis and Comment:* All the above findings indicated very clearly that the case was a straightforward typical one of lymphadenosis or leukæmia in dog, but in which the blood picture showed a non-specific leucocytosis (this peculiar type of disease in the dog has been outlined above). On the 19.7.46 it was considered the animal showed early inanition with cardio-vascular signs and the polypnœa and compensatory tachycardia suggested some reduction in pulmonary vital capacity probably due to involvement of the lung. The gross deterioration and general health in the nine days before it was placed on urethane indicated that the disease was running a very acute course, and, in fact, the dog shortly after was so ill that the owner had considered destruction. In brief, there was every indication that life could not be expected to be prolonged for more than a matter of a few days or, at the most, a week.

5. *Treatment*: Subsequent observations are given below. The results of the blood examination are given in text Fig. 1 in a graphic form. Differential counts were done on each examination, but only the initial one is given above. Unfortunately, it was not possible for a photograph to be taken before treatment began, but on the 2.8.46 the animal was in a condition similar to that depicted in Fig. 2, taken just before death.

Urethane in syrup was given *per os* in doses of ½ and 1 gm. twice daily, together with a special ration of horse meat.

3.8.46. *Urethane therapy commenced*—1 gm. daily.

4.8.46. Dog very much worse; comatose with marked swelling of the face. Emaciation marked (compare Fig. 2), owner considering euthanasia. *Urethane increased* to 2 gm. daily.

8.8.46. Very marked improvement. Dog alert and energetic, appetite ravenous. Leucocytosis has disappeared. Polypnœa much decreased. History of transient complete blindness with a red coloration of the eye (the exact nature could not be determined) on 5 and 6.8.46. Dog completely recovered (Fig. 1).

14.8.46. Improvement continues. Dog sleeping rather more than usual, but very energetic when awake. Lymph nodal enlargement much reduced. Ophthalmoscopic examination negative. Blood shows slight anæmia with moderate leucocytosis due to a neutrophilia. Lymphocytes reduced.

21.8.46. General health good; persistent diarrhœa developed without other gastro-intestinal signs. Lymph nodes only just palpable. Hæmotological findings now within the normal range of both red and white cells. Cardiovascular signs improved. *Urethane discontinued.* Respiration and temperature normal.

28.8.46. Diarrhœa ceased within 48 hours of discontinuing the urethane. Bodily condition excellent and weight increased. The lymph nodes enlarging slightly. Mild cardio-vascular signs—tachycardia, vagus arrhythemia—reappearing. *Urethane recommenced* at 1 gm. level daily. Marked leucocytopenia on account of this; *urethane discontinued* after two doses.

3.9.46. Dog in excellent condition. Lymph nodes slightly enlarged. Leucocytes returning to normal levels. *Urethane commenced* at 1 gm. level.

11.9.46. General condition excellent. Lymph nodes are no smaller.

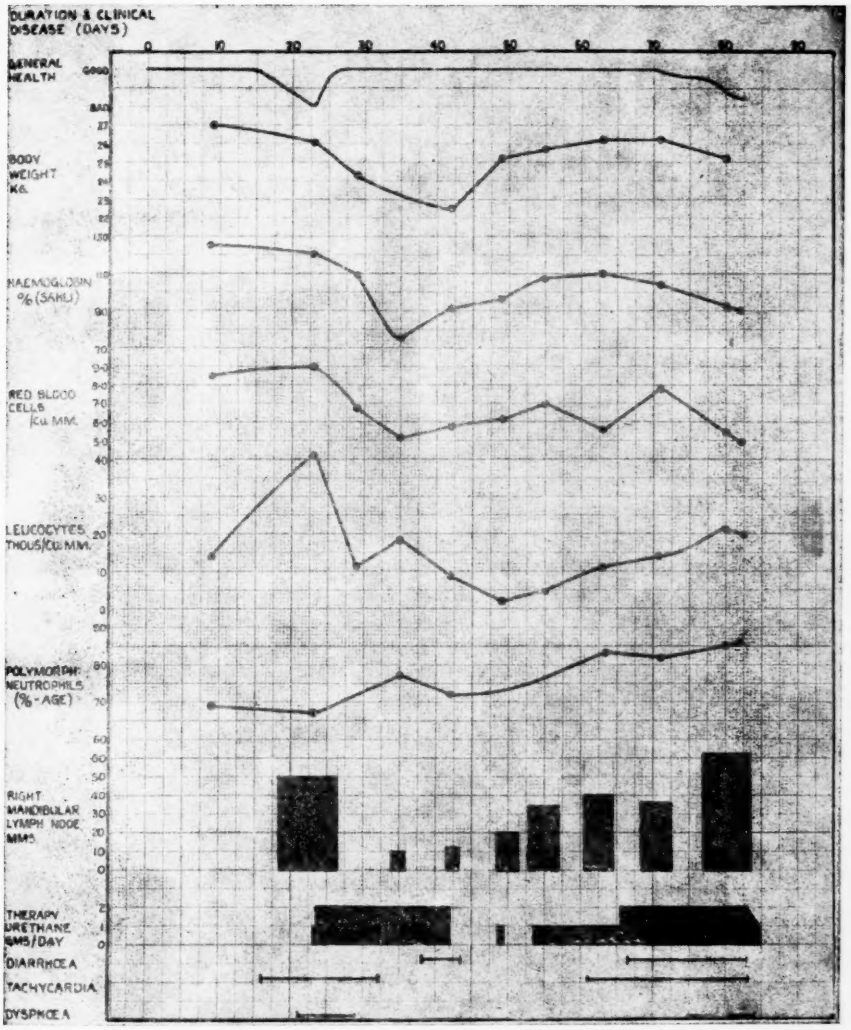
14.9.46. *Urethane—2 gm. daily.*

19.9.46. General condition excellent. Diarrhœa developed 48 hours after increasing the dosage. Tachycardia again present. Lymph nodes regressing slightly. Temperature normal; respiration is 50 and shallow. Dog sleeping more than usual.

27.9.46. Dog markedly worse. Body weight is down. Tachycardia more marked; moderate dyspnœa at rest with chest held in position of inspiration permanently. Slight diarrhœa persists. The deterioration commenced on 23.9.46 with inappetence, lethargy and enlargement of the lymph nodes, which are considerably larger than a week previously. Moderate leucocytosis, largely due to young polymorph neutrophils.

30.9.46. Dog very emaciated; anorexia is severe and the animal can only walk. Œdema of the submaxillary region again present. Muscles of the buttocks show marked wasting (see Fig. 2). Moderate leucocytosis only, but with a pronounced shift to the left in the Schilling index of the neutrophil polymorphs. Destroyed by intravenous administration of Nembutal (grs. 18 quickly produced only general anæsthesia), followed by a 25% magnesium sulphate solution. (The resistance to the effect of Nembutal was most pronounced.)

6. *Autopsy.* — *Summary of pathological findings:* Advanced emaciation. Localised gelatinous œdema extending from axillary region to mandibular space. Gross bilateral enlargement of mandibular, parotid, prescapular, axillary, supra-mammary, lymph nodes (mandibular about 60 x 45 cm.); nodes fleshy and soft,



freely movable with only occasional hæmorrhage; no necrosis; distortion of vessels and nerves of neck by nodal enlargement. Hypertrophic tonsils. Discrete focal hæmorrhages lower borders lungs. Massive enlargement all pulmonary and mediastinal nodes. Occasional subendocardial petechial hæmorrhage. Spleno-

XUM

megaly (30 cm. long—12 cm. base, weight—550 g./normal about 30-50 g.); firm in consistence, extension over midline to pelvic brim; no hæmorrhage or infarction. Gross enlargement of liver (weight = 1,600/normal about 850 g.). Bulky enlargement of all abdominal lymph nodes. No lesions, stomach, intestines, pancreas, adrenals, kidneys, female genitalia. Reddish-grey pulpy hæmorrhagic marrow (femora and humeri extending all along shaft). The histology of the tissues examined was in full accordance with the general description already given and some of the lesions are illustrated.

7. *Comment:* In view of the initial clinical findings and those at the autopsy, the case is clearly one of lymphadenosis or lymphatic leukæmia, in which the blood picture showed non-specific leucocytosis. We know that this disease in dogs, whether accompanied by a true leukæmic blood picture or not, runs an acute course and terminates fatally in a matter of a few months. When the animal begins to show cachexia, cardiovascular and respiratory signs and anorexia, death must be expected to take place at least in less than a week. This stage was reached when urethane therapy was initiated. The immediate response in improvement of general health, in the undoubted regression of lymph nodes, in the reduction of the leucocytosis and in a return to a most vigorous appetite was most spectacular and leaves little doubt that this was, in fact, due to urethane. The continued administraion of the drug, however, seemed to cause diarrhœa and aplasia of all nucleated cells in the blood, and these factors might prevent the continued administration of 2 gm. a day to a 25 kg. dog. These results are quite in accordance with those seen in human cases. The fact that the improvement was not maintained to result in a complete cure is also true of human cases and at the moment cannot be explained. It must be stressed that on the basis of this one case no exaggerated claims are made and an analysis of a much larger series is required. Although the mode of action of the drug is unknown, some preliminary studies on the toxicity of urethane in dogs indicates that it has a depressant action on the formation of leucocytes in general, and lymphocytes in particular, as shown by a distinct and relatively rapid fall in the circulating white cells.

Summary

1. A brief review of canine leukæmia is made.
2. A detailed record of a case of acute lymphatic leukæmia in a dog treated with urethane and in which spectacular improvement resulted, but was not maintained, is presented.
3. The effects of urethane are briefly discussed.

REFERENCES

Bloom, F., and Meyer, L. M. (1945): *Amer. J. Path., 21,* 683.
Boyd, W. (1943): Textbook of Pathology, 4th Edit., *London.*
Engelbreth-Holm, J. (1942): "Leukæmia in Animals," Oliver Boyd, *Edinburgh.*
Ibid (1946): *Proc. Roy. Soc. Med., 29,* 740.
Forbus, W. D., and Davis, C. L. (1946): *Amer. J. Path., 22,* 35.
Forkner, C. E. (1938): "Leukæmia and Allied Disorders," *New York.*
Furth, J. (1946): *Phys. Rev., 26,* 47.

Haddow, A., and Sexton, W. A. (1946): *Nature, 157,* 500.
Hutrya, F., Marek, J., and Manninger, R. (1938): Special Pathology and Therapeutics of the Diseases of Domestic Animals, *London.*
Jarmái, K. (1934): Ergebn. allg. path. Anat., *xxviii,* 227.
Joest, E. (1929): Handb. spez. path. Anat. d. Haustiere, *Berlin, 5,* 173, 1st Edit.
MacMahon, H. E. (1934): *Amer. J. Path., 10,* 309.
Paterson, Edith, Haddow, A., *et al.* (1946): *Lancet,* 677.
Piney, A. (1939): Recent Advances in Hæmatology, 4th Edit., *London.*
Robb-Smith, A. H. T. (1938): *J. Path. Bact., xlvii,* 451.
Vaughan, J. M. (1938): *Brit. Encycl. Med. Pract., viii,* 1.
White, E. G. (1946): *Proc. Roy. Soc. Med., 29,* 739.
Wirth, D. (1931): *Fol. Hæm., 2,* 242.

THE USE OF D.D.T. AS AN ANTI-TICK SHEEP DIP

By G. B. S. HEATH,
Ministry of Agriculture Veterinary Laboratory, Weybridge.

Introduction

HEATH AND MITCHELL (1946) reported on the use of sheep dips containing D.D.T. against the British sheep tick, *Ixodes ricinus,* L. They presented data which indicated that evaluation of anti-tick dips by means of tick counts alone might be misleading. Blaxter (1946) showed statistical analysis of counts to be of little use unless more detailed field observations are made. The present investigation was mainly concerned with detailed observations, but simultaneous large-scale tick counting was carried on at the same time.

Material and Methods

A group of 100 Swaledale and Herdwick sheep were dipped in an anionic emulsion, M 34 (Heath and Mitchell, 1945), at a bath concentration of 0.5% D.D.T. on March 12, 1946. Thereafter they were divided into two groups of fifty. One of these groups was dipped in M 34 on April 1, 8 and 29 and put through a foot and head bath of a cationic emulsion, M 37 (Heath and Mitchell, 1946), at a concentration of 0.5% D.D.T. on May 20. The other group was dipped in M 34 on April 8, and foot and head bathed in M 37 on April 1 and 22 and May 31. A further group of fifty sheep was left undipped as controls. Ticks were counted at approximately weekly intervals by the methods described by Macleod (1939).

For detailed observations, three sheep from each dipped group and six undipped sheep were marked individually. Thereafter, daily observations were made of each tick which attached to the face, ears and axillæ of these sheep. Macleod (1932) found that female ticks normally engorge in about seven to ten days. Observations made prior to and during this work indicated that, during the height of the tick season, some females may engorge in six days. Since ticks which do not complete engorgement lay no eggs or very few eggs (Campbell, 1945), and since a minimum of six days is generally required for complete engorgement, any tick which remained on the sheep for less than six days was

considered to have failed to engorge, thus causing a break in the life cycle. Ticks which survived for six days or more after attaching were classed as "engorged," unless they subsequently died on sheep. Daily records were kept of:

(a) Number of ticks which had attached since the previous day.

(b) Number of ticks which were "absent," i.e., ticks which had disappeared after being attached for less than six days.

(c) Number of ticks found dead on the sheep.

(d) Number of "engorged" ticks, i.e., ticks which had disappeared after being attached for more than five days.

When opportunity offered, engorged females and nymphs were collected from D.D.T. dipped and control sheep. They were placed in glass tubes plugged with cotton-wool, and kept in a common atmosphere saturated with water vapour. Periodically they were examined and their condition was noted.

Results

Daily examination of the sheep for three or four days after dipping showed that D.D.T. is only a moderate acaricide; freshly attached females were almost invariably killed, but females which had been attached for as long as four to five days usually appeared to be unaffected.

Results of large-scale tick counting are presented in Table 1. It will be seen that both dips gave a large measure of protection, but that M 37 was considerably better than M 34.

TABLE 1

Date.	Mean Tick Count per Sheep. Undipped (50 Sheep)	M 34 (50 Sheep)	M 37 (50 Sheep)
March 19	0.0	0.0	0.0
„ 24	0.7	0.2	0.2
„ 27	1.8	0.4	0.4
April 1	3.8	1.0	1.0
„ 8	5.3	2.8	0.3
„ 15	5.6	0.5	0.4
„ 22	3.3	0.5	0.2
„ 29	10.0	3.2	0.1
May 6	2.9	0.4	0.0
„ 13	2.6	0.3	0.1
„ 20	1.3	0.1	0.1
„ 31	4.6	2.3	1.4
June 13	6.8	4.0	1.3
„ 26	1.8	1.8	1.3
July 8	1.6	1.4	1.4

Table 2 shows the results of intensive tick watching.

TABLE 2

	(Undipped) (6 Sheep)	M 34 (3 Sheep)	M 37 (3 Sheep)
Number of ticks which attached	264	91	18
Number of ticks which disappeared 1 day after attaching	0	0	2
" " " " 2 days " " ...	6	3	0
" " " " 3 " " " ...	6	10	0
" " " " 4 " " " ...	16	8	2
" " " " 5 " " " ...	12	1	0
Number of ticks which died 1 day after attaching ...	10	11	9
" " " " 2 days " " ...	3	8	2
" " " " 3 " " " ...	4	4	1
" " " " 4 " " " ...	1	0	0
" " " " 5 " " " ...	0	2	0
" " " " 6 " " " ...	2	5	1
" " " " 7 " " " ...	1	3	1
" " " " 8 " " " ...	0	1	0
" " " " 10 " " " ...	1	0	0
" " " " 11 " " " ...	0	1	0
" " " " 16 " " " ...	1	0	0
Number of ticks which engorged 6 days after attaching	57	11	0
" " " " 7 " " " ...	49	15	0
" " " " 8 " " " ...	37	5	0
" " " " 9 " " " ...	30	2	0
" " " " 10 " " " ...	11	1	0
" " " " 12 " " " ...	5	0	0
" " " " 13 " " " ...	3	0	0
" " " " 14 " " " ...	3	0	0
" " " " 15 " " " ...	3	0	0
" " " " 16 " " " ...	2	0	0
" " " " 21 " " " ...	1	0	0

Table 3 presents the data of Table 2 in summarised form, expressing ticks found on dipped sheep relative to ticks found on control sheep, on a percentage basis.

TABLE 3

	(Undipped)	M 34	M 37
Relative numbers of ticks which attached	100	69	14
Relative numbers of ticks which completed engorgement	100	34	0
Percentage of attached ticks which died *in situ* ...	9	39	78
Percentage of ticks which detached before engorgement complete	15	24	22
Percentage of ticks which engorged completely ...	76	37	0

Large numbers of ticks were collected from D.D.T. dipped and undipped sheep, but, unfortunately, most of them were killed by moulds. Of those engorged females from undipped sheep which were unaffected by mould, 26 began to lay eggs less than 78 days after collection and the remaining four died. Of the six

females collected from D.D.T. dipped sheep and unaffected by mould, five were dead in less than 46 days and the other died 125 days after collection. It is regretted that so small a number of ticks were unaffected by mould, but, when taken in conjunction with results shown in Table 3, it appears that the chances of a female tick engorging on a D.D.T. dipped sheep and then laying viable eggs are remote.

The impracticability of making accurate counts prevented any attempt at recording nymphs and larvæ on the sheep. However, during the course of three years tick counting on sheep which have been dipped in D.D.T. emulsions, the opinion has been formed that nymphs are rarely killed by immersion in the dip, attach in large numbers within a few days of dipping, and engorge successfully on dipped sheep. Larvæ also appear to engorge successfully on recently dipped sheep. Two hundred and sixty engorged nymphs were collected from the undipped sheep, and 220 from D.D.T. dipped sheep; no evidence was obtained of any lethal effect in those from D.D.T. dipped sheep.

Discussion

Assuming a static tick population and remembering that the female tick produces up to 2,000 eggs, it follows that if males and females are produced in about equal numbers, only two (one male and one female) of the eggs are likely to produce adult ticks which successfully attach to the host animal. Hence, any attempt at eradication of the tick should be aimed primarily at killing, or rendering sterile, the females.

The work reported above indicates that D.D.T., especially if used in the form of a cationic emulsion, should break the life cycle of ticks which attach to dipped sheep by preventing any female from engorging and ovipositing. This makes its apparent ineffectiveness against nymphs and larvæ of minor importance as, in the absence of other host animals, serial dipping for three years of all sheep on a pasture should eradicate the tick. In the present work, no effort was made to discover the smallest number of dippings necessary during the tick season. This problem will be taken up in future work, although it is tentatively suggested that two dippings in a monophasic tick season or three in a biphasic season would be sufficient.

Summary

D.D.T. in the form of suitable emulsions markedly reduced infestation of sheep with *Ixodes ricinus*. For every 100 female ticks which attached to undipped sheep, 69 attached to sheep dipped in an anionic emulsion, and 14 to sheep treated by bathing head and feet in a cationic emulsion. A considerable proportion (24%) of attached ticks failed to engorge completely even on undipped sheep, but of 18 attaching to three sheep after treatment with the cationic emulsion, none survived.

Acknowledgments

This work was carried out under the auspices of a co-ordinating committee of the Agricultural Research Council and is published by permission of that Council, and of the Veterinary Laboratory of the Ministry of Agriculture.

The interest displayed by Dr. H. H. Green, under whose direction this work was carried out, is gratefully acknowledged, and thanks are due to Dr. D. D. Pratt and Mr. W. S. Greaves, of the Chemical Research Laboratory, Department of Scientific and Industrial Research, who supplied the dips used.

REFERENCES

Campbell, J. A. (1945): Private communication.
Blaxter, K. L. (1946): *Vet. J., 102,* May 5, 1946.
Heath and Mitchell (1946): *Ibid.*
Macleod, J. (1932): *Parasitology, 24,* 3.
Macleod, J. (1939): *Bull. Ent. Res., 30,* 1.

ANIMAL BEHAVIOUR IN RELATION TO VETERINARY SCIENCE

By B. A. CROSS

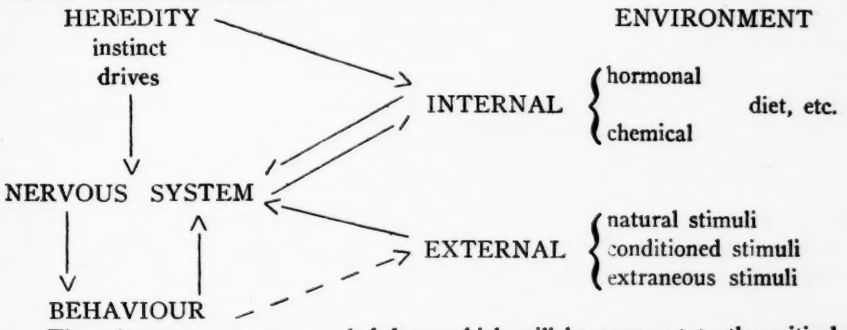
*Final Year Student, Royal Veterinary College.**

Introduction

It is proposed, in this paper, to give a brief account of some aspects of the behaviour of domestic animals in health and disease. Research trends will be exemplified, and an effort made to indicate the applications of the subject to veterinary matters. Certain lines of approach for future investigations will be suggested for discussion.

At present, our knowledge of the subject is in a somewhat disordered state. Much literature has been accumulating in recent years and many divergent theories of behaviour exist. Experimental techniques and the interpretation of results are undergoing constant revision, and the subject presents a formidable aspect to the general reader. It is not my intention to enter into theoretical controversy, but rather to present for consideration certain essentially practical items in animal behaviour.

It is necessary, nevertheless, for any understanding of animal behaviour to have some appreciation of the main factors concerned therein. A simple qualitative scheme would be as follows:—



The scheme possesses several defects which will be apparent to the critical observer, but it does afford a basis for examining behavioural phenomena. Being exclusively "mechanistic," it takes no account of purely psychic processes, but the author does not wish thereby to deny the possibility of their existence. The

* Presented to the Royal Veterinary College Medical Association on March 5, 1946.

scheme enables some conception to be formed of the interplay of the several important factors influencing the nervous system, which is, in reality, the fount of all true behaviour. In face of so many measureless variables, it is small wonder we are rarely able to prophesy behaviour; for though we may rigidly control the external environment and possess a fair knowledge of the genetic make-up in a given experimental case, it is a matter of exceeding difficulty to order a constant internal environment. It is the author's contention, however, that we should interest ourselves in patterns of behaviour, rather than attempting detailed analyses of complex neuro-muscular activities.

The ideal research worker in animal behaviour would require to be well versed in such varied subjects as neurology, psychology, endocrinology, animal husbandry, physiology, biochemistry, genetics, and pathology. Ideals seldom exist in reality, but in this matter the truth is that there is room for specialists in all these fields. Indeed, many notable contributions have already been made by such workers.

It is the author's plea that integration of scattered data is urgently required, and that some scheme for a disciplined further attack on behavioural problems should be evolved. This thesis will be elaborated later; meanwhile, it is proposed to give an account of certain relevant aspects of the subject.

Nutrition

Work on the behavioural aspects of nutrition has been extensive, and the following account is by no means exhaustive of present-day research knowledge.

Appetite or " food drive " is the spur to ingestion of food. We use the term " appetite " in a strict behavioural sense as meaning the sum total of genetic, nervous and metabolic factors, contributing to the animal's desire for food of a certain kind and in certain quantity. The mode of satisfying the appetite is in part conditioned also by external factors such as form and availability of food.

A large body of experimental and clinical evidence testifies to the fact that animals display a well-marked, self-regulatory behaviour with regard to ingestion of food. That is to say that food intake is adjusted to the needs of the animal if this is not rendered impossible, e.g., by domestication and human regulated dietary. Experimentally, positive correlations have been demonstrated between energy requirements of the body and utilisable energy values of food ingested. Haussmann[4] fed a group of rats in alternate periods with solid food of constant composition *ad lib* and a fixed quantity of aqueous solution of standard sweetness. During the first period this consisted of cane sugar solution, while in the second period it consisted of saccharin solution. The rats found both solutions desirable, but when given the energy-low saccharin solution they compensated for the energy deficit by eating a correspondingly greater quantity of solid food. The utilisable energy intake in each case was identical. They were similarly able to differentiate between solutions of alcohol of varying strengths, consuming proportionately larger volumes of the more dilute solutions.

In the experiments of Evvard[1] fattening pigs were given a free choice of food in an effort to determine their capacity for choosing an optimum diet. Shelled corn, meat meal, linseed oil meal, whole oats, limestone, charcoal, common salt and water were provided *ad lib*. The average live weight rose to 405 lb. in 247 days, while in the control group of pigs on a normal human regulated diet the average

live weight was only 300 lb. after the same interval. "The free choice system of feeding, whereby pigs have access to suitable feeds, enables and encourages maximum development: in other words, actually permits the inherited specifications to be fulfilled to all intents and purposes."

In similar self-feeding experiments on eight cows of medium productivity, Nevins[2] found that a good standard of health was maintained. The cows, however, tended to consume quantities of nutrients in excess of their calculated requirements and, consequently, put on weight. As a result their maintenance cost was increased, and it was concluded that the self-feeding method was uneconomical. Milk yields were not increased.

That rats possess well-defined appetites for protein, carbohydrate, sodium, phosphorus, potassium and vitamins was indicated in a set of experiments[3] in which eight experimental rats were presented with olive oil, cod liver oil, wheat germ oil, yeast, sucrose, casein, sodium chloride, calcium lactate, sodium phosphate and potassium chloride, all in aqueous solution. They chose optimal diets, the calorific values of which averaged 18.7 per cent. less than control rats on standard diet, due to the lower fat content of the latter.

The importance of the internal milieu in self-regulatory behaviour is further illustrated by a mass of data concerned with mineral, vitamin and endocrine metabolism. A few examples only will be noted. When fowls were provided with ordinary macaroni, the average voluntary daily intake of calcium in the form of oyster shell provided *ad lib* was 19 grains. When, however, they were fed with macaroni packed with powdered oyster shell in such a way that the birds were unaware of ingesting the latter, the average voluntary calcium intake was only 5 grains daily.[4] Cattle fed on a phosphorus-low diet frequently exhibited pathological osteophagic behaviour, which was eliminated by reintroduction of a sufficiency of phosphorus in the food.[5] The voluntary intake of sodium chloride by pregnant rats exceeded that of similar non-pregnant rats, and the salt consumption was reduced following parturition.[6] Adrenalectomy resulted in increased intake of sodium lactate and sodium phosphate, as well as sodium chloride tenfold in some rats.[7] Parathyroidectomised rats displayed an enhanced appetite for calcium.[8]

We have previously stated that factors, other than metabolic environment, are involved in the phenomena of appetite (see scheme). This statement is corroborated by the experiments of Wilder.[9] He found considerable variability in the ability of rats to choose an antirachitic diet in preference to a rachitic diet under different conditions, and concluded that individual preferences, habituation, taste, manner of presentation, etc., were all probably modifying factors.

Our definition of appetite included the phrase ". . . food of certain kind and in certain *quantity*." The mode of satiation of natural appetites presents a fascinating problem for the behaviourist. Why does an animal stop eating? The complete answer to this question is not simple. The experiments of Bayer[4] on fowls are illuminating and possess, besides, an intrinsic practical interest. Hens were fasted for 24 hours and then separately presented with a pile of 100 grains of oats. They consumed 50 grains each on the average, being then, apparently, satiated. If, however, the remaining food was brushed away and immediately replaced, the hens would continue to eat. This process could be repeated a

XUM

sufficient number of times to increase the oats consumed by 67 per cent. The quantity eaten was also related to the initial size of the heap. If a pile of 200 grains was given, 35-54 more grains were ingested at the first sitting. A further factor influencing consumption was the nature of the surface on which the grain was fed. Less was taken from a hard, resilient surface than from a soft one, due, it was concluded, to the painful effect on constant concussion of the beak. For a similar reason, greater quantities of large rice grains were consumed than of smaller grains, since the more frequent pecking entailed by the latter occasioned correspondingly more numerous painful stimuli. A single hen, which had ceased eating, could be induced to recommence by introducing a fresh, fasted hen into the pen (social facilitation). A small group of satiated hens, however, would not restart eating on the introduction of one further hungry bird, but formed, as it were, a separate "behaviour unit." These experiments well illustrate the influence of the external environment and nature of the stimulus on behaviour patterns.

The voluntary water intake of animals depends to an important degree on availability. If access to water is provided only once daily, e.g., in grazing cattle, the volume ingested is less than if two or more waterings are allowed. In other words, water appetite is determined by the immediate metabolic state rather than over-all requirements. It is accepted[10] that animals will not normally consume too much water, and it is now recognised that optimal water intake only occurs if it is constantly available. This principle has been adopted with considerable benefit to milk production in the form of automatic drinking bowls in byres. The physiologist can render valuable aid in this field by pursuing further investigations on the physiology of thirst in the different species.

Research into optimal conditions for ingestion and digestion of food for each species would pay big dividends. It is an aspect of the subject which could be applied readily to animal husbandry. In the scientific literature references are scanty, but a vast amount of information must surely be in the possession of stockkeepers and nutritionists, which only requires collecting, integrating and disseminating as widely as possible. One instance only will be mentioned. It has been found that divided mangers are preferable to continuous mangers in double stances in cow byres. If the trough is undivided, the cows tend to rush through their feed, and the first to finish may then proceed to eat her neighbour's ration. With individual troughs, each animal eats more slowly, more efficiently, and more contentedly. Further problems that would repay study are (a) the effects of competition between individuals; (b) the effect of extraneous stimuli on quantity of food ingested and efficiency of digestion.

Finally, elucidation of the factors concerned with individual characteristics, e.g., food preferences, is required. Few researches have been performed on individual animal psychology, most workers having been attracted rather to species or group behaviour patterns. Yet all equestrians, cow-keepers and dog-owners have their fund of stories about individual animals. Such anecdotal data belongs to an early stage of animal behaviour development, but there is a strong case for setting on foot an authoritative review of this collective experience and initiating controlled experiments. Much valuable information would result which would be of value, both to stockkeepers and veterinarians. Mention must here be made

of Blaxter's recent work at Shinfield[11] on "Food preferences and food habits of dairy cows." In this paper, besides a quantity of data on bulk of diet and satiation, the author gives some enlightening information on individual variations. He found food preferences varied between individuals, and even from day to day in the same individual. Cows varied in the rate of ingestion of different foods, also in the rate of ingestion of a meal consisting of one food only. The time taken to consume the following feeds showed variations as indicated:—

20 lb. mangels	14-24 minutes
6 lb. hay	35-65 „
5 lb. cattle cubes	5-8 „

The time required for eating a standard feed of mangels was positively correlated to the body weight of the cow, and in yard feeding from common troughs the larger animals not only ate faster than the smaller beasts but also tended to exclude the latter from the more nutritious portions of the feed.

All these phenomena, and many others besides, are invested with important implications which have still to be worked out by the veterinary behaviourist.

Sex

Attention has recently been drawn to sex psychology in the Central Veterinary Society discussion on "The examination of a stud bull for soundness,"[12] when D. L. Stewart communicated some pertinent observations on artificial insemination bulls at Shinfield. This subject is of considerable importance at the present time, and the A.I. centres would appear to offer obvious scope for organised behavioural research.

Walton[13] has maintained that species variations in male sex behaviour are correlated with their comparative anatomy and physiology. There remains, however, a large mass of data to be explained, particularly with regard to individual differences; and these, after all, are more likely to become the concern of veterinarians and stock-keepers. What makes a bull "slow"? How is libido related to circulating androgens and to environmental conditions? To what extent do genetic, nutritional and other endocrine factors influence sex behaviour? How far are purely reflex nervous actions implicated? I shall not attempt to answer all these questions, but will set down certain data which has a bearing on them.

Stewart reported that one old Shinfield bull persistently refused to serve teaser cows in the service crate in the yard. It showed no objection, however, to service when another crate was used in an adjoining field. Stewart concluded that the bull had at one time injured himself in the yard service crate, and subsequently associated pain with service in the yard. Another younger bull appeared to have developed a perversion of natural instinct. He would mount the teaser cow, but made no attempt to serve until the artificial vagina was placed in position.[12] Unfamiliar environment may in itself have an inhibitory effect on sex behaviour. A boar transported for service at a strange farm may show surprising disinterest in gilts or sows in heat, whereas service quickly follows the introduction of the identical females into his own pen.

Satiation of the sexual appetite is as much a problem as that of the food appetite. Staleness in stud animals is a complex phenomenon and is not related solely to the age and frequency of service. Observations on this aspect in the

XUM

larger domestic animals are difficult to find in the literature. Reference will be made, therefore, to some experimental work on fowls and rats, since they throw some light on the possible factors concerned in satiation.

Skard[4] made a series of interesting observations on the sex life of cocks. One old cock had a harem of 13 hens. The sexual activities of the cock were classified thus: (a) Ruffling neck feathers, (b) dancing, (c) placing foot on hen's back, (d) catching at hen's neck, (e) attempts at copulation. The hens reacted in varying ways: (a) Quiet acceptance, (b) shaking, (c) walking, slipping away, (d) faint screaming, (e) running and jumping, (f) crouching, (g) inviting, (h) screaming, (i) struggling. The cock's activities were studied in periods extending from 9 a.m. to 9 p.m. It was found that, generally speaking, the weaker sexual activities occurred in the morning, while attempts at copulation were more frequent in the later afternoon and evening. The hens mated were not necessarily those to which advances had been made earlier in the day. The number of copulations was correlated with the number of hens available on a given day. Thus, when allowed two hens only, 24 copulations occurred. With 26 hens, the number was increased to 46, while the average number of copulations when with his harem of 13 hens was 31. He seemed to possess a constant fund of sexual energy, compensating for over-indulgence on one day by diminished sexual activity on the next. He possessed definite favourites among the hens, though the criteria of his choice were indiscernible to the human observer! Broody hens were repugnant to him, but if segregated with one or two of them a few copulations would occur late in the day. It will be noted that these results are in some respects in striking agreement with Bayer's observations on food satiation in hens.

Work on mature male rats[13a] has demonstrated that extraneous stimuli can effect satiation. If under experimental conditions during the course of copulatory activity a stimulus such as the ringing of a bell was presented, the sexual behaviour invariably ceased and, for several minutes possibly, the male rate would show no interest in the female. An artificial "satiation" had been produced. If, on the other hand, the sound stimulus was withheld until copulatory activity had ceased naturally, i.e., until satiation had occurred, the male rat would, in most cases, restart the mating process. Paralleling this phenomenon is the experience of several observers[12] with stud bulls—namely, that changing the location of service or the teaser cow often stimulates the bull to fresh activity.

A large part of sex behaviour is undoubtedly greatly influenced by gonadotrophic hormones, especially pituitary, androgens and œstrogens. The behaviour of castrates, for example, is too commonly recognised to merit description here. The recent review of J. W. B. Douglas[14] on neuro-hormonal factors in sex behaviour provides a comprehensive résumé of experimental work, largely on rats, and concerned with the effects of ablations of parts of the nervous system and injections of sex hormones, etc. It might be mentioned here that hormone injections in bulls showing lack of sexual desire through no obvious cause have apparently little efficacy,[12] but in view of the multiplicity of factors involved, we should be cautious in interpreting such results.

The study of maternal behaviour in animals is a fascinating one. The following account of observations on maternal behaviour is included both for

its practical interest and also as illustrating a behavioural phenomena in which the internal environment appears to adopt a very dominant influence.

Many workers have endeavoured to measure the strength of sex drive in rats. The researches of Warden[15] using the Columbia obstruction box technique clearly indicated that the maternal drive was stronger than the sex drive. In fact, the maternal drive was found to be the strongest of all. Thirst came next, then hunger, sex and exploratory drive in descending order.

In domesticated animals, maternal behaviour in certain cases becomes perverted, due to maladjustment of the internal to the external environments. In Down flocks, for example, it occasionally happens that a parturient ewe will seize on a nearby newborn lamb and lavish maternal affection on it, resisting efforts on the part of the true mother to retrieve her offspring and regardless of the fact that her own lamb may be in the process of being born! The explanation of this curious behaviour would appear to be thus: Under conditions of domestication, the preparturient ewe is, in most cases, unable to segregate herself from the flock for lambing as she would do under natural conditions, e.g., hill sheep. In these latter conditions the ewe's strong maternal drive, at this time, is not subject to perversion by gratuitous presentation of a substitute lamb, but awaits the birth of the ewe's own lamb before receiving an outlet.[16]

Skard[4] made other observations on maternal behaviour in hens. The maternal phase lasted for about five to six weeks after hatching, and during this stage—the "clucking" stage—the hen would display considerable concern for the well-being of her brood. She demonstrated against removal of any of the family and would readily adopt orphan chicks. Her behaviour could not be described as reasoned, however, since if a glass cover was placed over a few of the young birds, she made no attempt to retrieve them. Towards the end of this period her behaviour underwent a change. She showed increasing intolerance for the chicks, which culminated in her angrily pecking at them when they approached too close. The significant fact was, however, that the chicks themselves were obviously not prepared for this treatment and had not yet attained a requisite measure of independence. This maladjustment was ascribed to the artificial feeding, which, as was intended, brought the hen into lay again in a shorter time than would occur under natural conditions. Egg laying and maternal behaviour demand different metabolic environments, so that when the hen was about to restart production the metabolic state militated against continued mothering of the chicks. If the hen had been fed on a restricted diet and the chicks on a lavish one, it might well have transpired that the chicks would have rebuffed the hen, while she herself was still at the height of the maternal phase.

Pseudo-pregnant bitches may display marked maternal reactions. Russell[17] described two such cases. In one an eighteen-month-old virgin fox terrier bitch, after a somewhat prolonged œstrus period, began to develop symptoms of pseudo-pregnancy, including swelling of the mammary gland. After seven weeks, she became "melancholy and worried," and a few days later she dug up a bone, brought it to the house, curled up around it on her bed, as if nursing, and growled when approached. This behaviour continued for some hours, after which she reburied the bone. The second case was that of a mongrel bitch, which regularly became pseudo-pregnant. On one occasion she was given three newly-

XUM

born rabbits by her master, which she received with obvious pleasure and which she even tried to suckle.

Rabbits are also prone to pseudo-pregnancy,[18] but in their case the symptoms are displayed at what would be mid-term, i.e., at about the eighteenth day after a sterile mating. The symptoms include plucking of the breast and the preparation of a nest with the fur.

A newly-calved cow has been known to expend her maternal drive on a stuffed calf, licking the skin so vigorously that the seams broke open. Whereupon the cow commenced unperturbably to consume the straw stuffing!

Production

Behavioural studies concerning production are at an early stage of development. There is room in this field for considerable further research and for a greater utilisation of present knowledge. Feeding is a prime factor in production problems, and some of the considerations supplied in the section on nutrition could, with equal force, be included here.

One of the biggest handicaps to maximum egg production is broodiness in poultry. The behaviour pattern of the broody hen has been appreciated for many years, but only comparatively recently have the controlling influences been remotely understood. It is now recognised[19] that hormonal factors are again concerned. Experimental work has shown that injection of prolactin, an ant. pituitary hormone, into fowls will produce broodiness. It also induces crop secretion in pigeons in which efforts to feed young also occur. Thus, this hormone appears to be an important factor in maternal behaviour. The experience of poultrykeepers would also indicate that the nature of the confinement of broody hens effect the duration of broodiness. As in all these phenomena, however, the totality of internal and external factors are by no means comprehended completely.

Our knowledge of the physiology of lactation has extended greatly in recent years. Now, for example, it is known that the "let down" of milk is not a voluntary act on the part of the cow, but results from a neuro-hormonal mechanism initiated by the natural stimulus of suckling or manual manipulation of the teat, or by the conditioned stimulus of washing down the udder prior to milking.[20] How many cows have been cursed and even struck for "withholding" milk when the real reason was the faulty technique of the milker? Milk production would undoubtedly show a definite increase if milking practice generally were brought into line with modern knowledge.

Probably the effects of extraneous influences at milking time are insufficiently appreciated. It would be interesting to compile statistics of herd yields on days when routine udder inspections had been carried out by Ministry inspectors during milking and the corresponding yields obtained in undisturbed milking periods. An incident was reported in *Veterinary Medicine* which is relevant to the present issue.[21] An American cowhouse was administered entirely by female workers, the cows being unaccustomed to male intrusion into the shed. When such an intrusion occurred inadvertently during one milking time, the herd showed a marked drop!

Some account will now be given of recent observations on grazing behaviour

in fattening animals, since they have an obvious relation to meat production, and also to pasture management. Johnstone-Wallace and Kennedy, of Cornell University, studied grazing activities in Aberdeen Angus and Hereford animals during the period 1931 to 1939, and recorded much valuable data.[22] Both breeds spent from seven to eight hours out of the 24 in grazing, and about seven hours in chewing the cud. Forty per cent. of the grazing was performed during the night-time. Calves were suckled three times during the day and night at approximately the same intervals, and for 15 minutes each time. Twelve hours were spent lying down; this period was divided into nine periods, varying in length from one to six hours. During the 24 hours spent on pastures of three to seven acres each, the cows travelled, on the average, 2½ miles, of which 2 miles was travelled in the daytime.

The pastures consisted of Kentucky bluegrass and wild white clover, and were grown at a high fertility level. The cows selected the leafy herbage in an immature stage of growth, seldom exceeding four to five inches in height. Herbage in the vicinity of droppings was avoided, and smell seemed to be the chief factor determining selection. On the average, the cows took 50 to 70 bites per minute and would sometimes graze continuously without raising their heads for as long as 40 minutes. About 32 lb. of dry matter, corresponding to 150 lb. green herbage, was consumed daily when the pasture was at optimal length, i.e., four to five inches. When the pasture length was ten inches, the average dry matter intake was only 20 lb., corresponding to 70 lb. of green herbage.

The cattle deposited twelve droppings daily, amounting to 46 lb. of manure and covering 8 sq. ft. Urination occurred nine times daily. From their observations, these workers were able to formulate principles for the most effective utilisation of rotational grazing and general pasture management for the feeding of beef cattle.

Similar work on grazing behaviour in sheep has been published by Stapleton and others. Among the interesting observations made were those on the hygienic habits of the animals. Sheep were found to deposit their droppings on the poorer parts of the pasture, thus fertilising these, while, at the same time, leaving the better quality grazing uncontaminated. Horses also confine defæcation to special poorer parts of the pasture. These facts have an obvious relation to parasitic spread.[23]

To return to fattening animals. There would seem to be plenty of scope for further behavioural research on fattening in yards, etc. Blaxter's observations, previously quoted, are significant in this respect; and studies might be made of social behaviour activities under such conditions. The phenomena of "dominance" and "bullying" in groups of animals of the same species are of considerable interest. Analagous studies have been made on the lower primates, rats and even fowls, but little work seems to have been performed on domestic animals where there is a definite practical application.

Health and Disease

Pathological behaviour is a subject of special interest to the clinician. In nine cases out of ten it is some alteration in the behaviour of an animal that induces the stock-keeper to call in the veterinary surgeon. Many of our diagnostic

XUM

aids are behavioural in origin. Colics, lamenesses, foreign bodies, picas are examples of derangements in which the patient's behaviour is a leading diagnostic factor. Then there are, of course, the nervous diseases in which diagnosis depends almost exclusively on behavioural reactions. It would seem desirable that efforts should be made to understand better the underlying causes and mechanisms of these pathological behaviour patterns.

On the positive side, it is the author's contention that study of optimal environmental conditions for health and production is an important task for the veterinary behaviourist. The results of his research would make an invaluable contribution to animal husbandry. The "mental" health of animals is largely an unknown quantity, but it nevertheless has a real significance. This is especially true of dogs. Canine patients undergoing treatment in strange infirmaries may frequently have their convalescence prolonged by the "mental" upset caused by the unfamiliar environment. This fact is recognised by many practitioners, who, accordingly, have their patients treated at home wherever possible.

The line of demarcation between purely nervous derangements and "psychological" illness is not clear. It is the conviction of many veterinarians, however, that the latter can exist as separate entities. At a recent discussion on "Non-Parasitic Pruritis" by the Central Veterinary Society,[24] Miss Joshua emphasised that scratching behaviour in dogs could be of psychological origin. In all probability canine hysteria is also, in part, psychological. One frequently reads in the lay press of cases of bereaved dogs pining for their masters. Here, surely, is an excellent subject for a thoroughgoing investigation by the veterinary behaviourist.

In the experimental field, mention must be made of the artificially induced "neuroses" in such varying species as dogs, cats, sheep and pigs, which closely simulated "nervous breakdown" in humans. The original studies were those of I. P. Pavlov in his pioneer work on conditioned reflexes.[25] Neurotic symptoms developed in his dogs when they were presented with too severe problems of stimulus differentiation, and on one occasion, when the dogs were nearly drowned in their cages, as a result of a gigantic flood in Leningrad. It is, at least, possible that analogous problems may confront the dog in domesticated conditions, for example, in the case of dogs owned by people of unstable temperament. One would not be surprised to find neurotic manifestations in a dog that never knew whether to expect petting or punishment. Pavlov found considerable variation in individual susceptibility to experimental production of neurosis, and on the basis of these, and other results, he was able to classify dogs into psychological types. He also studied the methods by which the neuroses could be cured. Related to these latter researches was his work on the behavioural actions of drugs, especially bromides.

In view of the paucity of published data on mental diseases in animals, the case recently cited by MacCurdy, of the Cambridge Psychological Laboratory, is of great interest.[26] The patient was a 4½-year-old dachshund: "A good-tempered friendly dog . . . considered to be highly intelligent by his owners who had a fairly wide experience of dogs." After a comparatively mild concussion, the dog suffered a very marked change of character, which manifested itself in a regressive behaviour with loss of social and domesticated reactions. Before

the accident he was an active dog who would play by himself with a ball in the garden; was fond of rabbiting and going shooting with his master. He tended to be oversexed. He was house-trained in a very short time, but he persisted in the female squatting position for urination until nearly adult. His only neurotic trait was a fear of trains that dated from puppyhood and endured until his fourth year. On November 13, 1937, he was hit by a motor-car, but, though dazed, showed no evidence of being stunned. A few hours later he had a series of epileptic fits and afterwards showed no recognition of his master or mistress. He was kept in an infirmary for twelve days, during which time he took little interest in his surroundings. On returning home, his behaviour was markedly altered. He recognised the house and knew his way about. He also remembered some of the simpler tricks he had learned in connection with feeding, but he defæcated and urinated indiscriminately for some weeks. He had reverted to his old habit of squatting for urination, and this continued for four weeks. He stole food and ate until vomiting occurred. He showed little spontaneous activity and had lost his previous sociability, displaying none of his affection for his owners. He was nervous and excitable and showed a "wildness" when but slightly provoked. He made none of his usual advances to the bitches in the neighbourhood. Improvement was slow and had attained its maximum pitch by nine months after the concussion. He was then fairly normal, but had turned into a "lazy old dog," prematurely senile, lethargic, uncertain of temper and lacking sex appetite. He was destroyed two years later after a particularly wild outburst on a station platform where his old fear of trains had reappeared.

I have purposely avoided discussion on the animal "mind" in this paper, and it is a subject on which there is a large measure of disagreement. It is obvious, however, that certain behavioural phenomena are difficult to explain completely in terms of present-day anatomy and physiology. In particular, our knowledge of the neurology of domestic animals is totally inadequate. In the author's submission, therefore, further neurological research should be initiated, rather than that energies should be diverted into the production of somewhat nebulous psychological speculation on animal behaviour. If this were done, cases such as that of MacCurdy outlined above would be more comprehensible to the veterinary practitioner. In this paper the term "psychological" has been used to characterise behavioural phenomena which are not, at the present time, readily explained in terms of commonly accepted scientific concepts.

Conclusion

This paper has been concerned with relations rather than mechanisms. It has indicated the depths of our ignorance rather than the extent of our knowledge. In so short a compass, it has not been possible to do real justice to a vast subject. Mention has been omitted of many significant branches of the subject, such as heat regulatory behaviour, discriminative abilities, fœtal behaviour, learning processes and inheritance of behaviour traits. It is hoped, however, that the evidence has been sufficient to convince the reader of the profound relevance of the study of animal behaviour to livestock problems generally and veterinary science in particular.

XUM

The following steps are now submitted for consideration as methods of furthering behavioural science:—

(1) A comprehensive and authoritative review of behavioural data relating to domestic animals.
(2) Active planning and pursuit of research on special aspects of behaviour at appropriate existing institutions, e.g., A.I. Centres, Veterinary and Agricultural Colleges, Animal Hospitals, etc.
(3) Setting up of special animal behaviour stations with specialist research workers somewhat on the lines of that already functioning at Cornell.

Some of the problems awaiting investigation have been suggested in the body of this paper. Broadly, they fall into two classes:—

(1) Detailed observation experiments such as those of Johnstone-Wallace on grazing behaviour of beef cattle.
(2) Experiments concerned with mechanisms of behaviour, e.g., neurological, endocrinal, nutritional and genetic studies.

It must be emphasised that animal behaviour is essentially a unified study. The divisions made in this paper were purely arbitrary, and various items presented might equally well have been placed in two or more of the sections. Sex and feeding behaviour are obviously linked with production, while all three are related to animal health. Furthermore, behavioural phenomena should also be considered in relation to biological knowledge. For example, it has been maintained that preclusion of natural "love play" is one of the contributory factors in "lazy" bulls, since bringing a bull straight from his pen to an immobilised teaser cow, which may not even be in œstrus, is scarcely conducive to quick, effective service. In other words, it is "unbiological."

Summary

(1) The main factors concerned in behaviour and their inter-relationships are indicated.
(2) Nutritional aspects of animal behaviour are considered with special reference to normal and pathological appetites, self-regulatory behaviour, environmental conditions and individual characteristics.
(3) Some account is given of sex behaviour in domestic and experimental animals and the modifying effect of internal and external factors is illustrated.
(4) The application of the study of animal behaviour to egg, milk and meat production is suggested, and reference made to grazing behaviour in relation to pasture management, etc.
(5) The significance of behavioural studies for the clinician and hygienist is noted and reference made to "psychological" upsets in animals.
(6) A plea is made for a concerted attack on behavioural problems by specialist workers in many fields.

Acknowledgments

I wish to acknowledge my indebtedness to Dr. R. Braude, of the N.I.R.D., Shinfield, for advice, particularly concerning nutrition, and to Prof. A. N. Worden, of Aberystwyth, without whose interest and encouragement this paper would not have been published.

REFERENCES

(1) Evvard, J. M.: "Is the appetite of swine a reliable indication of physical needs?" *Proc. Iowa Acad. Sci.*, 1916, vol. 22, pp. 375-414.

(2) Nevins, W. B.: "Experiments in self-feeding of dairy cows." *Bull. No.* 289, Illinois Agr. Expt. Sta., 1927.

(3) Richter, Hold and Eckert: "Nutritional requirements for normal growth and reproduction in rats studied by the self-selection method." *Amer. Journ. Phys.*, 1938, vol. 122, pp. 734-744.

(4) Quoted D. Katz: "Animals and Men. Studies in comparative psychology," 1937.

(5) Green, H. H.: "Perverted appetites." *Phys. Reviews*, 1925, vol. 24, pp. 547-577.

(6) Barclare and Richter: "Increased sodium chloride appetite in pregnant rats." *Amer. Journ. Phys.*, 1938, vol. 121, pp. 185-188.

(7) Richter and Eckert: "Mineral metabolism of adrenalectomised rats studied by appetite method." *Endocrinol.*, 1938, vol. 22, pp. 214-224.

(8) Richter and Eckert: "Increased calcium appetite of parathyroid-ectomised rats." *Endocrinol.*, 1937, vol. 21, pp. 50-54.

(9) Wilder, C. E.: "Selection of rachitic and anti-rachitic diets in the rat." *Journ. Comp. Psych.*, 1937, vol. 24, pp. 547-577.

(10) Linton, R. G.: "Animal nutrition and veterinary dietetics," 1943.

(11) Blaxter, K. L.: "Food preferences and habits in dairy cows." *Proc. Brit. Soc. Anim. Prod.*, 1944.

(12) Scorgie, N. J., Stewart, D. C., and Conn, E.: "The examination of a stud bull for soundness." *Vet. Rec.*, 1945, vol. 57, p. 459.

(13) Walton, A.: "Comparative sexual behaviour in the male." *Proc. Royal Soc. Med.*, Sept., 1944, p. 660.

(13a) Quoted Grindley, G. C.: "Intelligence of Animals."

(14) Douglas, J. W. B.: "Nervous and hormonal factors influencing sexual behaviour." *Bull. Anim. Behav.*, 1941, vol. 1, No. 2.

(15) Warden, C. J.: "Relative strength of primary drives in the white rat." *Journ. Genet. Psych.*, vol. 41, p. 16.

(16) Fraser, A.: "Sheep Farming."

(17) Russell, E. S.: "Behaviour of Animals. An introduction to its study," 1933.

(18) Marshall, F. H. A.: "Physiology of Reproduction," 1922.

(19) Riddle, O., Bates, R. W., Lahr, E. L.: "Prolactin induces broodiness in the fowl." *Amer. Journ. Phys.*, 1935, vol. 3, pp. 352-360.

(20) Ely, F., Peterson, W. E.: "Factors involved in the ejection of milk." *Journ. Dairy Sci.*, 1941, vol. 24.

(21) "Veterinary Medicine," 1945.

(22) Johnstone-Wallace, D. B., and Kennedy, K.: "Grazing habits of beef cattle." *Journ. Agric. Sci.*, vol. 34, part 4.

(23) *Proc. Brit. Soc. Anim. Prod.*, Oct., 1944, p. 102.

(24) Joshua, Miss J., Iszard, P., and Worden, A. N.: "Non-parasitic pruritis in dogs." *Vet. Rec.*, 1945, vol. 57, p. 153.

(25) Pavlov, I. P.: "Conditioned Reflexes," 1927.

(26) MacCurdy, J. T.: "Regression in dog following concussion." *Bull. Anim. Behav.*, 1944, vol. 1, No. 4.

GENERAL

Washburn, M. F.: "The Animal Mind," 1926.

Frolov: "Pavlov and His School," 1937.

Munn, N. L.: "An Introduction to Animal Psychology," 1934.

Moss, F. A.: "Comparative Psychology," 1942.

Alverdes, F.: "Social Life of Animals."

Barcroft, J.: "The Brain and Its Environment."

Allen, E.: "Sex and Internal Secretions," 1939.

XUM

CLINICAL ARTICLE

CASE OF LYMPHADENOSIS IN A THOROUGHBRED STALLION

By J. B. TUTT, M.R.C.V.S.
Winchester.

Subject.—Thoroughbred stallion, age 9 years.

History.—First symptom was that it was noticed to be off its food and to have a slight cough.

Symptoms.—At the first examination the animal was found to have a temperature of 102.6° with enlargement of the submaxillary lymph glands. These glands were firm to the touch and there appeared to be little pain associated with them. No other special symptoms were noted.

Sulphanilamide orally was prescribed, and the glands poulticed. During the next fourteen days very litle change was seen in the condition of the patient; the appetite remained poor and the condition of the glands did not alter. There was, however, a marked general wasting in the bodily condition of the subject, with slight posterior locomotor ataxia. A large œdematous plaque developed under the abdomen and the inguinal, prescapular, and pharyngeal lymph glands were found to have become bilaterally enlarged. At this stage, G. P. Male, Esq., of Reading, was called in as a consultant.

Under his direction, a rectal examination was carried out. This examination revealed enlarged mesenteric lymph glands and an enlarged spleen. The fæces were mucous covered; the mucosa of the mouth was sticky and dirty yellow in colour. The temperature was normal, and had been so for several days. A tentative diagnosis of a leukæmia was made. Samples of blood were taken with blood smears, which were dispatched to the Royal Veterinary College, who reported as follows: " The blood sample was clotted, but ordinary cultures remained sterile. No marked increase in the white cells was seen in the smear (white cell count not performed), and the differential count is within normal range (counts vary in different parts of the smear, but the average is 55 per cent. neutrophils, 35 per cent. lymphocytes). These findings suggest that the leukæmia, if present, is not leukæmic."

A biopsy of one of the lymph glands was suggested, but the animal died before this could be carried out. The length of the illness had been approximately four weeks.

During this period various lines of treatment had been carried out, including epsom salts as a laxative, with arsenical preparations.

Post-mortem examination revealed gross bilateral enlargement of the submaxillary, parotid, bronchial, mediastinal, prescapular, hepatic, gastric and splenic lymph glands. The liver weighed 30 lb. and the spleen weighed 26 lb. No other lesions were to be found. Portions of the liver, spleen, and lymph glands were dispatched to the Royal Veterinary College, and the report was as follows:

XUM

"Histology of the lesions add to the support of a diagnosis of lymphatic leukosis. The liver does not show any marked changes, but the spleen and lymph nodes appear packed with round lymphoid cells which have mostly a moderate amount of cytoplasm and a darkly staining nucleus, although some of the nuclei are pale and vesicular. Mitosis is not obvious in the round cells."

Remarks.—Lymphadenosis in the horse, according to standard works, appears to be a rare condition. The similarity to the condition seen in the dog is noted, especially the early clinical symptoms, slight rise in temperature with a cough. The marked wasting was a very noticeable feature of the condition.

ABSTRACT FROM CURRENT LITERATURE

ATROPHIC RHINITIS IN PIGS
(CASE REPORT)

By CARTER H. ANTHONY, M.A., D.V.M.
Kansas City.

History.—The owner purchased seven gilts and one boar of registered Hampshire stock in the fall of 1945. Gilts were bred in a few weeks to the boar and all were in good health, apparently. About six weeks later the boar began to show symptoms of sneezing and lacrimation, as if taking cold. Three weeks from farrowing time, one of the gilts went off feed and later farrowed eight pigs, all dead except one that survived only a few hours. Recovery was slow, requiring about two months. Other gilts were normal, farrowed normally, and seemed healthy until weaning time. Sneezing, lacrimation, and temporary blindness were observed. Anorexia was present in all cases, and hidebound condition with dryness, thickening and scaling of the skin appeared. Symptoms in weanling pigs —itching was noted that was not relieved by external applications. Sneezing and distortion of the snouts developed in some small pigs, and normal growth had been impaired. Sow and pigs continue to sneeze.

Laboratory Findings.—A live pig from this bunch was submitted, and, when first seen, a lateral tilt of the head to the right was noticed. This pig was in fair flesh and no external lesions were evident. On post-mortem, the inside diameter of the right nasal passage was found to be about one-half that of the left. No inflammation or evidence of exudate could be found. All internal organs appeared normal, except that the cerebral vessels were decidedly injected.

Comments.—The symptoms and course of the disease have much in common with a recently reported swine disease, termed a new type of "Bullnose," or what is more aptly described as atrophic rhinitis. This newer condition differs from the older type primarily in the physical changes seen, i.e., a definite distortion of the snout rather than a bulging. Also, it starts with sneezing and lacrimation, and is seen in suckling pigs as well as older animals.

Our laboratory findings were inconclusive in this case. Cultures of the sinuses yielded *Pseudomonas æruginosa,* while growth from other tissues was absent. Pseudomonas is typically a pyogenic type of organism, but no evidence of a suppurative process was found in this case.

Canadian Journal of Comparative Medicine and Veterinary Science, Vol. 9, No. 8.

XUM

NEWS

PIGS AND ACORNS*

DURING the worst years of the war the ancient practice of feeding acorns to pigs was revived in many parts of the country. Animal feeding-stuffs are still short, and as acorns contain a large amount of digestible carbohydrate they are a form of food that should not be entirely neglected, since they are capable of replacing part of the cereal allowance in the pig's ration. Each 1 lb. of raw, unshelled acorns is equivalent to about ½ lb. of barley meal.

For feeding purposes acorns should be gathered in as dry a condition as possible and then spread out on a floor to become thoroughly dry before storing. Any that have become mouldy or musty-smelling during storage should be thrown out.

It is difficult to lay down any definite rule as to the weight of acorns that can be fed to pigs without causing digestive troubles and constipation. The introduction of acorns into the ration must be gradual, the amount being increased according to the animal's reaction. Normally, when fed indoors, up to 1 lb. per head per day can eventually be given to bacon pigs, and up to 2½ to 3 lb. for suckling sows. Acorns tend to cause constipation, and pigs feeding on them should always have access to green food and water. Fish meal, if available, also helps to counteract this tendency.

A very good feeding meal can be made by grinding over-dried acorns. Sifting separates the meal from the husks, and the meal has a feeding value nearly equal to that of barley meal; in addition, it is more palatable. As with feeding acorns whole, the meal must be introduced gradually and the maximum weight fed should no exceed 2 lb. per day a head to replace the same weight of barley meal.

Fresh acorns should be fed only to older pigs and acorns in any form are probably better out of the rations for pregnant sows.

While the feeding of acorns or acorn meal is found to be successful with pigs, no attempt should be made to feed them to dairy cows or beef cattle, as cattle are susceptible to acorn poisoning.

* Ministry of Agriculture and Fisheries Weekly News Service, No. 360, September 30, 1946.

APOLOGY

We regret that owing to the breakage of the block in Messrs. May & Baker's advertisement during printing in the November issue, the leading line read "Ravenous Anæsthesia in Small Animal Practice." This was owing to the first three letters breaking away, and the line should, of course, have read "Intravenous Anæsthesia in Small Animal Practice." We would ask Messrs. May & Baker, Ltd., to accept our apology for this mistake.

Publishers' Notices

Copy of advertisements should be in the hands of the publishers—Baillière, Tindall and Cox—not later than the 1st of the month, if proof is required.

Letters for the Journal, literary contributions, reports, notices, books for review, exchanges, new instruments or materials, and all matter for publication (except advertisements) should be addressed to the Editor.

Binding Cases for Volume 99 and any previous volumes can be obtained from the Publishers. Price 3s. 9d. post free.

Annual Subscription, 30s. ($6.00 U.S.A. currency, post free.)

XUM